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## REGENERATION IN MANZANITA.

WILLIS L. JEPSON.

In the Oakland Hills there may be found two manzanitas that are species of *Arctostaphylos* growing in localized areas. *Arctostaphylos andersonii* Gray grows on the main ridge a mile south of the summit of the Snake Road which leads into the headwater basin of San Leandro Creek. *Arctostaphylos glandulosa* Eastw. grows on the same ridge on yellow shale, and also abundantly on Moraga Ridge on the same formation. A number of years ago while making field studies of these shrubs, my attention was directed to the rather striking fact that individuals of *Arctostaphylos andersonii* had been killed outright by fire, and that *Arctostaphylos glandulosa* was stump-sprouting abundantly from heavy root-crowns. No root-crown or tabular development at base of the stem could be found in the former species, nor even any attempts at root sprouting at all, while in the case of the latter species the root-crowns became very heavy, globose, or turnip-shaped, or even eventually forming broad tabular areas of irregular shape at the surface of the ground. Since then many further observations have been made upon the species of this genus in various parts of the state to determine if reaction to fire ran parallel with the specific limitations.

*Arctostaphylos andersonii* is a larger shrub, eight to twelve feet high. One individual within a few feet of the bridle-path along the eastern brow of the Oakland Hills, and about half-mile south of Snake Road summit, is sixteen feet high, with a trunk circumference of three feet nine inches, at six inches above the ground. As said above, this species is killed by fire. Trunks decapitated four feet high failed to regenerate. This species may be recognized by its densely set leaves, which are heart-shaped at base, and by its very close flower-clusters. (Pl. I.)

*Arctostaphylos glandulosa*. This is a rather low-growing species of the immediate coast region, occurring in formations of considerable extent on slopes of yellow shale. It is perhaps the most remarkable species in California in the matter of its behavior under repeated fire devastation. After the stems are fire-killed, young plants begin to form a root-crown which becomes turnip-shaped or globose (Fig. 1) and lies immediately at or below the surface of the ground. As the plants increase in age and fires continue to run, as characteristically in chaparral, the root-crowns increase in size (Pl. II, A) and give rise to many stems. While at first small, root-crowns often become two to five, or indeed ten to thirteen, feet broad.

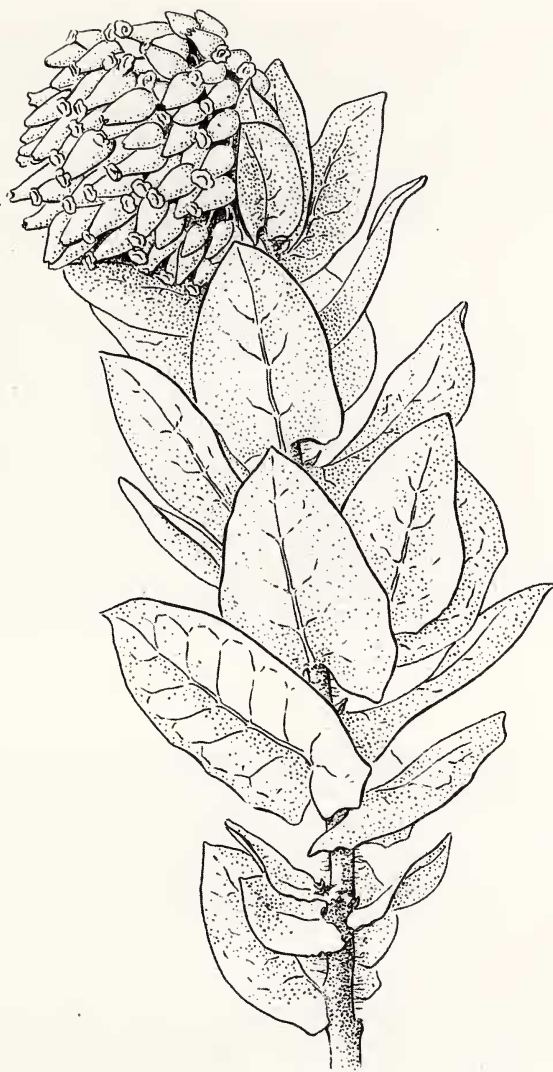
The very large ones form irregular circles or crescent-shaped areas, and are truly remarkable structures. (Fig. 2) Such crowns can be studied to advantage upon the southeastern slopes of Mt. Tamalpais or in the Oakland Hills just south of the low wagon pass

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at the headwaters of Kohler Creek, and along the summit of Moraga Ridge, where the species is associated with Knob-cone pine in a characteristic habitat. The vitality of the species must be normally very great. After the Mt. Tamalpais chaparral fire of early July, 1913, sprouts began to appear within four weeks, and in two months made an abundant showing. Two of my students, Wieslander and Herbert, counted forty-eight sprouts in a square inch from the crown of an individual of this species occurring on Mt. Tamalpais in the area subject to the fires just mentioned.



FIG. 1.

*Arctostaphylos vestita*. This species occurs on the Monterey Peninsula in company with the Monterey pine, and on the mesa east of Del Monte in the chaparral. It exhibits habits exactly similar to *Arctostaphylos glandulosa* and forms heavy root-crowns. These Monterey shrubs do not seem to be specifically, although they may be varietally, different from the shrubs of Mt. Tamalpais, which are taken as *Arctostaphylos glandulosa*.

*Arctostaphylos tomentosa*. This species is well developed along the Washington and Oregon coasts, and extends southward in typical form to the Mendocino coast. Within the limits of this range it is well characterized by the long, somewhat scattered bristles of its branchlets, in addition to a fine tomentum, which is rather close and dense. It also occurs in Marin County, especially about Point Reyes, and in the Santa Cruz Mountains, but within this portion of its distribution—that is at its southern limits—it becomes difficult to distinguish from *Arctostaphylos glandulosa*. There is however a fundamental difference between the typical forms that, so far as observed, is invariable—namely, as to their reaction to fire. *Arctostaphylos tomentosa* on the Mendocino coast is quite killed by fire,



A.—*ARCTOSTAPHYLOS GLANDULOSA*



B.—*ARCTOSTAPHYLOS NUMMULARIA*

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and, so far as observed, reproduces entirely by seed. Mr. W. C. Mathews, one of my students, who has also observed it on the coast region of Mendocino, has given me the results of identical observations on this species. *Arctostaphylos glandulosa*, on the other hand, as noted above, flourishes under fire, and establishes heavy sub-hypogeous platforms from which sprouts freely rise after fire.



FIG. 2.

*Arctostaphylos nummularia* is another coast species. (Fig. 3.) It is very erect, with the branchlets crowded with small round leaves. While locally abundant, and even gregarious (Fig. 4), it is in general a rather rare species, and my observation of its behavior on Mt. Tamalpais shows it to be killed outright by fire. (Pl. II, B.) One of my former students, Miss C. M. Hoak, makes a similar observation for the Mendocino White Plains. It may be that the restricted occurrence of this species is due to its inability to respond vegetatively from the root after chaparral fires, a fact which may perhaps be connected with the character of its root-system, which is spread out near the surface of the ground like an inverted umbrella. In any event, the roots lie so near the surface of the ground that they must suffer directly from the heat of chaparral fires (Fig. 5.)

*Arctostaphylos stanfordiana* is a species of the Mt. St. Helena range. It is remarkable for its deep-green glabrous leaves, and clean, trim habit, and is susceptible of field recognition in this way by those who notice manzanitas. This species, according to the available evidence, does not reproduce vegetatively. This testimony I had first from Mr. Carl Purdy, who lives in its region, and Miss

Hoak, on her own initiative has confirmed this observation, although further field notes on this species are desired. I have seen it many times in the field, but never where the fire evidence was very clear.

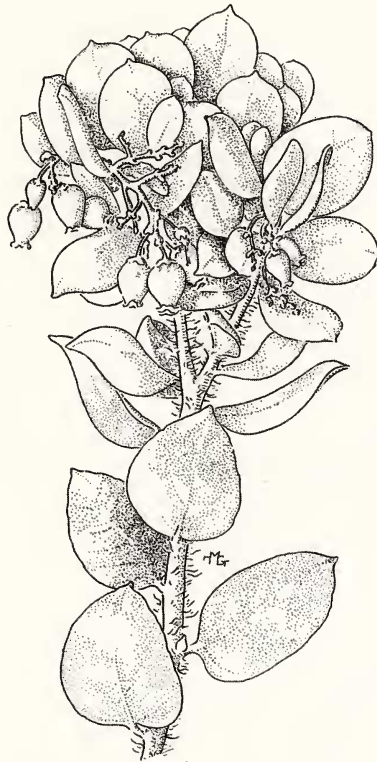


FIG. 3.

*Arctostaphylos patula* is the common species of the main coniferous belt in the Sierra Nevada from the south to the north, and west to Mt. Shasta and Trinity Summit. It is a shrub four to six feet high, and is remarkable for its rather dark but lively green and shining foliage. Under fire killing of its crown, or even apparently in advance of such killing, this species forms a turnip-shaped or globose root-crown that continues to increase in thickness and persistently sprouts under the successive conflagrations that run through the chaparral. Winter snowfall is heavy in this region. Its branches in consequence often lie along the ground, at least as to their lower part, and so take root. Spreading of the species in a given area may occur only in this way—that is, by the rooting of ascending or horizontally spreading branches.

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Just here I may revert for a moment to *Arctostaphylos stanfordiana*. In the character of its branchlets, and in its inflorescence, this species is so similar to *Arctostaphylos patula* that the two can scarcely, it would seem, be held as distinct, or in any event it is plain that they lack sufficient differentia. Their difference in behavior under fire, however, helps to make good this lack of technical distinction.

*Arctostaphylos manzanita*, as to regeneration, is one of the vaguest of the earlier published species with which we have to deal. As to its reaction to fire, a definite report is not yet ready.

*Arctostaphylos viscida* grows in the Sierra Nevada foothills. The southern form of it has very viscid berries, and is known as *Arctostaphylos mariposa*. Without for the moment going into the matter of the exact status of *A. mariposa*, one may safely say that this white manzanita of the Sierra foothills is in hue the most sharply defined manzanita in California. Its foliage is very glaucous, or even quite silvery, and presents a most striking yet most pleasing contrast to the deep-red bark. My experience is that this species is killed under fire, an observation which has ample confirmation from the experience of settlers in the southern Sierra Nevada in clearing land of chaparral. In an area where, as the saying is, "everything sprouts," they have noticed that this white manzanita does not do so. Mr. Ralph Hopping, Insect-control Expert of the United States Forest Service, also confirms the non-sprouting of *Arctostaphylos viscida*, or in any event its southern form.

To fix the limit of species of *Arctostaphylos* in California has always been difficult, and those who have studied the genus as it occurs with us have recorded widely divergent judgments as to the number of species that are to be recognized. The discrimination of proposed species, however, by all authors, rested upon differences of pubescence, glandulosity and habit. The character of the nutlets and their degree of separation or coalescence has also been used,



FIG. 4.

but is, on the whole, so variable that only slight importance can be attached to it, except in one or two species.

Search for technical characters for the separation of species has been carried on by the writer, but has been to a large degree unsatisfactory in results. Experience, both in field and in herbarium, determines that habit, general aspect, and hue must be taken as of first importance in segregation, although pubescence and glandulosity would have practical value in the construction of diagnoses. Now, if the Californian species be segregated on this basis, one obtains about twenty species. These species, I may say, fall into five or six fairly natural groups, the species in each group being very closely related. In successive attempts to determine the most satisfactory criteria for separating the species within each group, all possible information regarding the life history was sought. As a result, it was found that within the limits of a group the differential mortality of two species very closely related is markedly decisive. As this cleavage is largely between closely related species rather than between groups, the difference in reaction to fire is highly interesting, and is also, evidently, of taxonomic value. In other words, the working conception of species above outlined seems to be unexpectedly fortified by their habits in relation to fire—that is, of root-crown sprouting or of failure to do so.

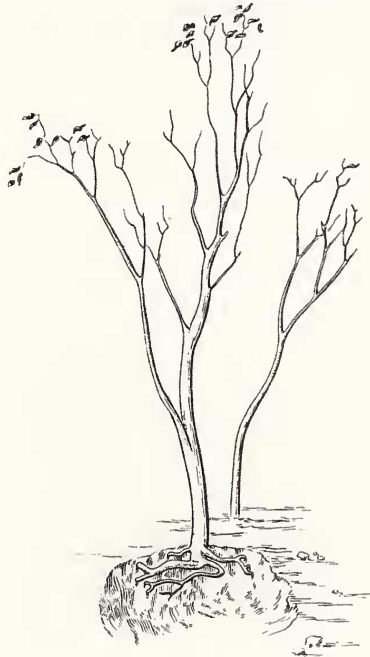


FIG. 5.



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While the number of observations that have been made are not sufficiently large or geographically extensive to warrant final conclusions, the results so far are interesting, and are here put on record to draw out criticism and to stimulate further observations. One set of observations in a given locality, however faithful and accurate, cannot be regarded as entirely sufficient, because in other genera of the chaparral stump-sprouting varies within a species. This variation may be related to the age, vitality, soil situation of the individual, or to some other cause, such as variation in the mutilating or destroying agent, fire or the axe. An excellent example of such variation may be had from *Ceanothus sorediatus*. *Ceanothus* is a favorable genus for comparison in the matter of stump-sprouting, as many of its species are typical chaparral shrubs. In the Oakland Hills *Ceanothus sorediatus* (Jim brush) has been observed to stump-sprout freely; on Mt. Tamalpais we have found it killed outright by fire. While this difference in behavior in a single species has thus far not been observed in any species of manzanita, ampler records based on a wider range of observations, are desired.